Implementation of SABSOON

Harvey Seim, phone (919) 962-2083 email harvey_seim@unc.edu
John Bane, phone (919) 962-0172 email bane@email.unc.edu
Francisco Werner, phone (919) 962-0269 email cisco@email.unc.edu
Department of Marine Sciences, University of North Carolina, Chapel Hill, NC 27599-3300
fax (919) 962-1254

Jackson Blanton, phone (912) 598-2457 email jack@skio.peachnet.edu
Richard Jahnke, phone (912) 598-2491 email rick@skio.peachnet.edu
James Nelson ,phone (912) 598-2473 email nelson@skio.peachnet.edu
Gustav-Adolf Paffenhöfer, phone (912) 598-2489 email cmp@skio.peachnet.edu
Skidaway Institute of Oceanography, 10 Ocean Science Circle, Savannah, GA 31411
fax (912) 598-2310

MaryAnn Moran
Department of Marine Sciences, University of Georgia, Athens, GA 30602-3636
Phone (706) 542-6481 fax (706) 542-5888 email mmoran@uga.cc.uga.edu

Richard Zepp
National Exposure Research Laboratory, Ecosystems Research Division, U.S. Environmental Protection Agency, 960 College Station Rd, Athens, GA 30605-2700
Phone (706) 355-8117 fax (706) 355-8104 email zepp.richard@epamail.epa.gov

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LONG-TERM GOALS

We are developing an interdisciplinary real-time coastal ocean observing network to provide users with continuous information on coastal ocean conditions. A number of applications for this network are being pursued. Resource managers and the weather service are using the routinely observed data to better predict and manage the use of the South Atlantic Bight (SAB) coastal waters. Academic researchers are using the network for targeted research and as a test bed for sensor development. The network will also serve as the nucleus of an observing system that will provide in-situ observations for a nowcast/forecast regional coupled ocean/atmosphere model of the SAB.

OBJECTIVES

The continuing implementation of the South Atlantic Bight Synoptic Offshore Observational Network (SABSOON) involves expanded deployment of data acquisition and sensor carriage systems at as many of the eight offshore platforms as possible, and refinement of an onshore data management and distribution system. A focus at this time is the design and deployment of communications and power systems at the outer (remote) towers. We intend to develop a flexible offshore facility that can host a variety of scientific, educational and environmental monitoring activities.

APPROACH

In collaboration with the southeast Tactical Aircrew Combat Training System (TACTS), offshore platforms, or towers, owned and operated by the U.S. Navy are being instrumented with oceanographic and meteorological sensors. The effort involves interfacing science power and communications needs with existing TACTS equipment on the platforms. At each tower instrument systems are deployed which are for the most part readily serviced from the platform (i.e., without a ship or divers). Power is generated on-site, and data are relayed in real time by wireless communications to shore. Storage at each instrumented platform is used to buffer the data and provide a backup in cases of tower-to-shore communications failure. Onshore, the observations are archived, processed, and distributed to various users. These currently include academic researchers and the National Weather Service. Recent observations are also made available through the Skidaway web site (www.skio.peachnet.edu/projects/tower.html).

WORK COMPLETED

Phase 2 of the project, the extension of the network to multiple towers, is underway. Instrumentation of tower M2, the second master platform to be occupied in the network, is now complete. A RD Instruments acoustic Doppler current profiler (ADCP) has been deployed in a bottom-mounted frame roughly 200 m from the tower since April 2000 measuring water velocities at 1 m vertical intervals from near the ocean floor to near the ocean surface. It is connected to the tower by cabling permitting real-time reporting of the current observations. Other instrumentation at M2, deployed in early September 2000, includes near-surface and near-bottom SeaBird 37-SI conductivity/temperature/-pressure sensors, Wetlabs chlorophyll-*a* fluorometers, and LICOR irradiance (PAR) sensors. The lower sensor package also carries a Wetlabs transmissometer. An above-water PAR sensor is attached to the platform to provide simultaneous solar radiation values, permitting the calculation of optical attenuation coefficients to multiple depths. The support frame for the in-water sensor packages at M2 was re-designed to provide greater safety for operators, better accessibility to the sensors and better control of tension on the support cables. The re-design builds on experiences gained from use of a similar system deployed at tower R2. The new system (Figure 1) was installed over the summer of 2000.

Platform R2, the first master platform instrumented in the TACTS system, has been fully instrumented since October1999 with two meteorological packages, in-water sensor packages, a surface wave/tide pressure sensor, and a underwater video camera system for fisheries studies (see Seim 2000 for details). In December 1999 a dedicated PC was deployed at tower R2 to ensure continuous data collection, and there have been no data losses due to the communications system since that time. Observations from all instruments in the network are collected at least every six minutes and relayed once an hour to Skidaway Institute over a wireless microwave local area network.

Design of power and communication systems for the NE remote tower, R8, is complete, and system components are being acquired. The design work is the accomplishment of Travis McKissack, the chief engineer on the project. Extensive consultations with Navy personnel indicate that the existing power systems on the smaller remote towers do not have the output capacity required for SABSOON. In brief, it was determined that the Navy could not permanently make available the power at levels originally discussed in the initial project planning; that is, power provided to SABSOON could be withdrawn if required for the TACTS operations. This was deemed unacceptable for the SABSOON objective of real-time continuous data acquisition, and we are deploying power and communication systems that will be independent from those of the Navy at the remote platforms.

Figure 1. The in-water instrument support frame deployed at the SW corner of tower M2. The guide cables are fixed to diver-installed embedment anchors and tensioning is set with a turn-screw on the frame. Instrument carriages are mounted on the guide cables and raised/lowered with a central winch cable (not yet installed in this photo). The hinged floor panel on the extending section, opened for deployment and recovery of packages, provides a solid deck for servicing. A portion of the recently upgraded TACTS solar panel array is visible in the right foreground.

The R8 power system will provide a minimum of 250 watts continuous power at 24 VDC. To ensure uninterrupted power the system is designed to run off a 2200 Ah battery bank for 96 hours without recharge. Solar cells, a wind generator, and a propane generator (permanent magnet, brushless, bearingless) provide power input to recharge the battery bank. A charge controller will regulate power and provide information on power usage and status and usage of the battery bank and recharge systems. The communications system will extend the local area network to the remote tower and is designed for reliable transmission over a 25 mile open water path between antenna elevations of 100 to 160 feet. Two 2.4 GHz spread spectrum transceivers are configured as 10BaseT ethernet bridges with a maximum data rate of 2Mbps. Open mesh parabolic antennae are used to minimize wind loading on the antenna truss.

RESULTS

The network has been operational since May 1999 and we have gained considerable experience in its operation since that time. Biofouling of optical equipment has been the most significant problem in maintaining data quality. Three different types of optical configurations are employed in the sensors currently deployed, and the antifouling strategies recommended by sensor vendors have met with varied success. To inhibit fouling of the collector plate of the PAR sensor, a TBT-impregnated ring (Oceanographic Systems, West Palm Beach, FL) was mounted around the sensor. Based on measurements before and after cleaning, this system has been effective for periods of up to 2 months (during fall and spring). The chlorophyll-a fluorometers are closed sensors that must be pumped. A SeaBird TBT impregnated plug is attached to the pumped intake, and initially a bromine canister was used downstream of the chl-a fluorometer. In early 2000 significant biofouling led us to replace the bromine canisters with in-line copper tubing, a recommendation of Dr. Tom Dickey, and this strategy has been reasonably effective in preventing fouling between monthly cleanings. The CDOM fluorometer has an open optical configuration with external excitation and emission windows and has been most affected by bio-fouling. A TBT-impregnated block (Oceanographic Systems) has provided anti-fouling protection for the excitation/emission windows, but bio-fouling of adjacent surfaces has interfered with the CDOM signal. Hydroids can extend into the open optical path, causing a spiking of the output signal. There has also been an accumulation of debris from tube-building amphipods in the instrument housing around the optical windows that may also contribute to spiking of the fluorescence signal. Enclosure of the optical end of the instrument with a copper mesh has not eliminated bio-fouling and the intermittent signal spiking, but appears to have stabilized the baseline signal. A despiking routine implemented for the processing of the CDOM fluorescence data appears to be effective.

The observational database is actively being analyzed. Meteorological instrumentation has been deployed for more than a year. Climatology over this time has been consistent with previous studies, but over a dozen high-frequency extreme wind events (wind speeds > 40 m/s) associated with convective activity during frontal passages over the shelf have come as a surprise. These events produce 5 °C decreases in air temperature in less than 6 minutes, implying severe downdrafts, and have occurred repeatedly during all seasons. Heat budget studies of the coastal ocean, carried out using the meteorological packages mounted at the top of the towers, find a good correlation between predicted and measured ocean temperatures as ocean temperatures decrease in the fall, but fail to predict the rate of ocean temperature rise in spring when stable atmospheric conditions dominate. Recalculation of the heat budget using measurements from the second meteorological package, that is closer to the ocean surface, significantly improve the predictions, and indicate an opportunity to better understand the modulation of boundary layer fluxes by a stable marine atmosphere.

Ocean temperature and salinity measurements document low-frequency excursions of Gulf-Stream derived waters onto the mid-shelf, and extended periods of stable stratification when fresher coastal waters have spread out to mid-shelf from the inner shelf. Both events occurred during wintertime when conditions were presumed to be well-mixed and little influenced by the Gulf Stream. The long period of the events (from weeks to a month in duration) is not consistent with forcing by the synoptic wind field and may be a response to remote forcing by the Gulf Stream (Savidge et al., 1992). Low-frequency variations in mean sea level bolster this assumption.

Maxima in chlorophyll fluorescence have been associated with storm events when surface waves are large and light levels decrease significantly. The sandy sediments of the shelf support an abundant benthic diatom community, and the fluorescence maximum is believed to be due to resuspension of the diatoms by the surface wave field (Nelson et al., 1999). Maximum wave heights on the shelf occur at periods of 8-12 seconds and are observed to be very strongly damped once active wind forcing is removed (for example, after the passage of a hurricane), suggesting high rates of energy dissipation in the bottom boundary associated with the surface wave field.

Full-depth water velocity observations have been collected since April 2000. They capture the polarization of the tidal and subtidal barotropic flows on the shelf where depth-averaged tidal currents are largely rectilinear and directed across isobaths (e.g. Pietrafesa et al., 1985) and depth-averaged subtidal (wind-forced) flows are principally along isobaths (e.g. Lee et al., 1985). A first-baroclinic-mode-like flow dominates the subtidal cross-shelf circulation. Short period (<2 hour) events resembling internal wave packets have been observed repeatedly over the summer, suggesting that soliton-like waves, now recognized as being a common feature during summertime in the mid-Atlantic Bight, may also be present on the mid to outer shelf of the South Atlantic Bight

IMPACT/APPLICATIONS

Full implementation of SABSOON will provide the scientific community, resource managers, and educators with real-time access to the coastal ocean. We feel this will enhance our understanding of the physics, biogeochemistry and ecology of the coastal zone, provide a monitoring system for coastal resources and coastal hazards, and a interactive observational system that can be used by educators to study coastal issues.

TRANSITIONS

Observations collected by SABSOON are being shared with a number of investigators. Tower R2 is a registered CMAN (Coastal Marine Automated Network) station (ID SPAG1) and hourly observations are transmitted to the World Meteorological Organization's Global telecommunications systems and available worldwide. Dr. Dana Savidge (currently at NOAA's Pacific Marine Environmental Laboratory) is investigating Gulf-Stream forcing of the shelf with the observations, and Drs. Susan Lozier (Duke Univ.) and Larry Pratt (WHOI) are using SABSOON tide and current observations in their studies of predictability of non-linear systems. Dr. Jim Demmers (Ga. Tech. Res. Inst.) is pursuing development of interactive K-12 educational units using the SABSOON observations.

RELATED PROJECTS

Other direct partners in this NOPP-funded effort are Richard Bolin with TACTS in Beaufort, SC, Dr. Charlie Barans with the Marine Resources Division of the Department of Marine Resources in South Carolina, and Dr. Reed Bohne of the NOAA Gray's Reef National Marine Sanctuary (GRNMS). A new NOPP-funded effort, "Limited-area operational coastal ocean models: assimilation of observations from fixed platforms on the continental shelf and far-field forcing from open ocean models", lead by Dr. Daniel Lynch of Dartmouth College, will make extensive use of the SABSOON observations in a coastal ocean and coastal atmosphere modeling effort over the next three years.

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PUBLICATIONS

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